ADVANCED TECHNOLOGY MICROWAVE SOUNDER (ATMS)

PERFORMANCE AND OPERATIONS SPECIFICATION (POS)

June 23, 2000

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

INTEGRATED PROGRAM OFFICE
SILVER SPRING, MARYLAND

**ADVANCED TECHNOLOGY MICROWAVE
SOUNDER (ATMS)**

**PERFORMANCE AND
OPERATIONS SPECIFICATION
(POS)**

June 23, 2000

GODDARD SPACE FLIGHT CENTER   INTEGRATED PROGRAM OFFICE
GREENBELT, MARYLAND   SILVER SPRING, MARYLAND

Performance and Operations Specification

for the NPP/NPOESS Programs

ATMS Instrument

Prepared under the direction of:

Original signed by
_____
Sergey Krimchansky, NASA GSFC   Date
ATMS Instrument Manager, NPP

Reviewed By:

Original signed by
_____
Ray Taylor, NASA GSFC   Date
Project Formulation Manager, NPP

Original signed by
_____
Don Blersch, IPO   Date
Space Segment Manager, NPOESS

Approved By:

Original signed by
_____
Christopher J. Scolese, NASA GSFC   Date
Associate Director of Flight Projects for EOS

Original signed by
_____
John D. Cunningham, IPO   Date
System Program Director, NPOESS IPO

GODDARD SPACE FLIGHT CENTER   INTEGRATED PROGRAM OFFICE
GREENBELT, MARYLAND   SILVER SPRING, MARYLAND

RELEASE
DATE: **DOCUMENT CHANGE RECORD**   SHEET

CHANGE DOCUMENT:			COPY NO.
NUMBERED		REVISION	DATED
CHANGE (DATE)	TO INCORPORATE THE CHANGE INTO THE DOCUMENT: 1. ADD PAGES 2. REMOVE PAGES		OTHER COMMENTS REGARDING THIS CHANGE (AUTH., INSTRUCT., ETC.)
Baseline Version 6/23/2000	All pages affected		Approved by CCR 429-00-06-004
CH-01 8/16/2000	Replace page iii, page 8, and page 18		Approved by CCR 429-00-06-006
CH-02 7/30/2001	Replace page iii and page 10		Approved by CCR 429-01-06-011
CH-03 10/25/2001	Replace page iii, vi, 1, 2, 3, 5, 23, A-1, B-1, B-3, D-1 through D-9 and page E-1		Approved by CCR 429-01-06-012
CH-04 10/29/2001	Replace page iii, and page 22		Approved by CCR 429-01-06-010R4

NOTE: After revising the document, file this sheet in document preceding table of contents.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

APPENDICES

1.0   SCOPE

1.1   IDENTIFICATION

This Sensor Performance and Operations Specification sets forth the requirements for the Advanced Technology Microwave Sounder (ATMS).

1.2   SENSOR OVERVIEW

The purpose of ATMS is to collect microwave radiance data that when combined with the CrIS data will permit the calculation of atmospheric temperature and water vapor profiles.

1.3   DOCUMENT OVERVIEW

This document contains all performance requirements for the ATMS sensor. This document and the National Polar-Orbiting Operational Environmental Satellite System (NPOESS)/NPOESS Preparatory Project (NPP) General Instrument Interface Document (GIID), 06 August 2001 version, define all sensor/spacecraft interfaces for the ATMS. The term "TBD" applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term "TBS", means that the government will supply the missing information in the course of the contract. The term "TBR" means that the requirement is subject to review for appropriateness by the contractor or the government. The government may change "TBR" requirements in the course of the contract.

CH-03

Appendix D identifies exceptions to the NPOESS/NPP GIID, 06 August 2001 version, are applicable to the ATMS. Appendix E is the NPOESS/NPP GIID, and Appendix C defines the acronyms and abbreviations used throughout the document.

CH-03

1.3.1   CONFLICTS

1.3.1.1

In the event of conflict between the referenced documents and the contents of this specification, the contents of this specification shall be the superseding requirements.

1.3.1.2

In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the contracting officer shall determine the order of precedence.

2.0   APPLICABLE DOCUMENTS

2.1   GOVERNMENT DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is TBR.

2.1.1   SPECIFICATIONS

2.1.2   STANDARDS

2.1.3   OTHER:

GSFC 429-00-06-02	ATMS Statement of Work	
GSFC 429-00-07-03	ATMS Mission Assurance Requirements	
GSFC 429-99-06-01	ATMS Unique Instrument Interface Document (UIID)	CH-03
	NPOESS/NPP General Instrument Interface Document (GIID), 06 August 2001 version	

2.2   NON-GOVERNMENT DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

2.2.1   STANDARDS:

CCSDS 701.0-B-2 Nov. 1992	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification
TBD	NPP Spacecraft ATMS ICD
TBD	NPOESS Spacecraft ATMS ICD

2.3   REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the specification refer to them.

2.3.1   SPECIFICATIONS:

2.3.2   STANDARDS:

2.3.3   OTHER:

3.0   SENSOR REQUIREMENTS

3.1   DEFINITION

3.1.1   ATMS DESCRIPTION

- The ATMS shall be a total power microwave radiometer system.
- The ATMS shall consist of one instrument.
- The ATMS shall be compatible with both the NPOESS Preparatory Project (NPP) and the NPOESS satellite architectures.
- On-orbit calibration is required in all channels.
- The ATMS shall contain a diagnostic capability that produces data for use in ground analysis of individual radiometric channel performance.

3.1.2   SPECIFICATION TREE

Figure 3-1 depicts a partial specification tree for the NPOESS System.

3.1.3   TOP-LEVEL ATMS FUNCTIONS

The ATMS instrument shall perform the following functions.
- Scene radiance measurement.
- On-orbit calibration.
- On-orbit monitoring of calibration sources and instrument response changes.
- Acquisition of sensor health and status data.
- Generation of data streams containing scene radiance, calibration, monitoring, health and status data.
- Reception of command and control data.
- Accepting S/W uploads from the S/C
- Accepting calibration tables from the S/C

3.1.4   ATMS MODES

The ATMS shall implement the following modes as a minimum.

- OFF Mode
- OPERATIONAL Mode
- DIAGNOSTIC Mode
- SAFE-HOLD Mode
- SURVIVAL Mode   CH-03

3.1.5   ATMS MODES DESCRIPTION

3.1.5.1   Sensor-Off Mode

In the Sensor-Off mode, no power is supplied to the sensor.

3.1.5.2   Operational Mode

3.1.5.2.1
The sensor shall be in full functional configuration during the Operational Mode.
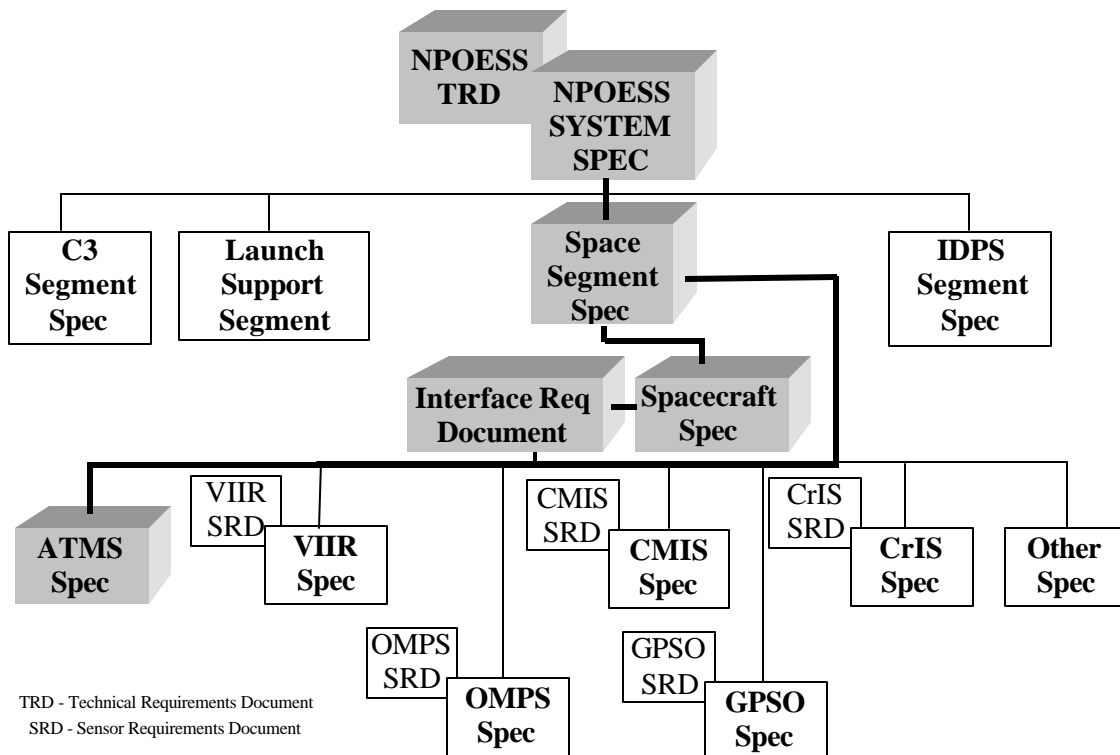
Figure 3-1   Partial Specification Tree for the NPOESS System

3.1.5.2.2
Mission and housekeeping data shall be collected.

3.1.5.2.3
Calibrations shall be performed during regular operations.

3.1.5.3   Sensor Diagnostic Mode

3.1.5.3.1
Diagnostic mode shall include trouble shooting and software updates.

3.1.5.3.2

The ATMS shall be capable of stopping at each scan position and providing radiometric data and status /engineering telemetry.

3.1.5.4   Sensor Safe-Hold Mode

In the Safe Hold mode, health and status data shall be collected and transmitted. Mission and calibration data are not collected. In Safe Hold mode, most components are turned off. During Safe Mode, no survival heater power is needed unless the spacecraft's ATMS Cold Plate temperature drops below –20º C.   CH-03

3.1.5.4.1

The Safe Hold Mode shall be a power conservation mode. The Sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event.

3.1.5.4.2

In response to a spacecraft C&DH-issued power conservation, re-configuration commands to the sensors via the data bus, the ATMS shall place itself into a safe configuration. The return to the Normal Operations Mode requires ground intervention.

3.1.5.5   Sensor Survival Mode

In the Survival Mode, the instrument operational power shall be off, with survival heaters activated.   CH-03

3.1.6   SENSOR SPECIFIC MODES

3.1.6.1

The ATMS ICDs shall define sensor modes.

3.1.6.2

The ATMS shall adhere to the Safe-Hold Mode re-configuration commands defined in the ICD.

3.1.7   OPERATIONAL AND ORGANIZATIONAL CONCEPT

3.1.7.1   Launch Operations Concept

3.1.7.1.1   Pre-Launch

The satellite, on which the ATMS is attached, will be transported to the launch base where final vehicle preparations and checkout shall be accomplished. Final inter-segment and launch system verification tests shall be accomplished prior to launch.

3.1.7.1.2   Launch and Injection

During launch and injection to the operational orbit, the ATMS shall be turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by stored command. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection. Transmission of launch vehicle telemetry will satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. Early orbit check-out will be conducted at the NPP primary Satellite Operations Control Center (SOCC) at TBD for the NPP ATMS and at NPOESS primary SOCC in Suitland, MD for the NPOESS ATMS.

3.1.7.2   On-Orbit Operational Concept

The NPP satellite will operate in a near-polar circular, sun-synchronous orbit with a 1030 local descending node at an altitude of approximately 824-km.

The NPOESS satellite shall operate in a near circular, sun-synchronous orbit. The nominal orbit for the satellite is 833-km altitude, 98.7-degree inclination. The orbit will be a "precise" orbit (i.e., altitude maintained to $\pm$ 17 (TBR) km, $\pm$ 0.05 (TBR) degrees inclination, nodal crossing times maintained to $\pm$ 10 minutes throughout the mission lifetime) to minimize orbital drift (precession). NPOESS shall be capable of flying at any equatorial node crossing time. However, the nominal configuration is with the satellite orbits equally spaced at 1330, 1730, and 2130 local ascending nodal crossing times..

The sun Beta angle, β, is the angle between the solar vector (i.e., the spacecraft-sun line) and the orbit plane. For instrument thermal design purposes, the range of β for the NPOESS missions is $\pm$ 90 degrees. The satellite will maintain the sun on the appropriate side of the spacecraft to meet the 'all beta' requirement.

3.1.7.2.1

The ATMS instrument design shall be such that data acquisition and necessary calibrations can be completed if the satellite is flown with any equatorial crossing time (ascending or descending). Selection of a specific orbital time of day, for NPOESS satellites, will be made 60 days before launch.

3.1.7.2.2

ATMS shall meet its Specified performance for any of the orbits in 3.1.7.2.

3.1.7.2.2.1 On-Orbit Tests

The initial on-orbit period is devoted to a complete spacecraft checkout and the calibration and performance verifications of the payload. The spacecraft and payload performance verification tests may be repeated at appropriate times during the

operational phase of the mission.

3.1.7.2.2.2 On-Orbit Operations

In normal mode, the sensor shall be capable of operating continuously without additional commands.

3.1.8 MISSIONS

The mission of the ATMS is to collect specialized data to permit the calculation of atmospheric temperature and water vapor profiles.

3.2 SENSOR CHARACTERISTICS

3.2.1 PERFORMANCE REQUIREMENTS

3.2.1.1 Channels

ATMS shall meet the characteristics defined in Table 3-1.

3.2.1.2 Beam Scanning

3.2.1.2.1
Each channel of the ATMS is considered to form a beam.

Table 3-1   ATMS Channel Characteristics

Channel	CENTER FREQUENCY (GHz)	MAXIMUM BANDWIDTH (GHz)	CENTER FREQUENCY STABILITY (MHz)	TEMPERATURE SENSITIVITY (K) NEΔT	CALIBRATION ACCURACY (K)	STATIC BEAM WIDTH θ_B (degrees)	QUASI POLARIZATION	CHARACTERIZATION AT NADIR (REFERENCE ONLY)
1	23.8	0.27	10	0.9	2.0	5.2	QV	window-water vapor 100 mm
2	31.4	0.18	10	0.9	2.0	5.2	QV	window-water vapor 500 mm
3	50.3	0.18	10	1.20	1.5	2.2	QH	window-surface emissivity
4	51.76	0.40	5	0.75	1.5	2.2	QH	window-surface emissivity
5	52.8	0.40	5	0.75	1.5	2.2	QH	surface air
6	53.596±0.115	0.17	5	0.75	1.5	2.2	QH	4 km ~ 700 mb
7	54.40	0.40	5	0.75	1.5	2.2	QH	9 km ~ 400 mb

Channel	CENTER FREQUENCY (GHz)	MAXIMUM BANDWIDTH (GHz)	CENTER FREQUENCY STABILITY (MHz)	TEMPERATURE SENSITIVITY (K) NΔT	CALIBRATION ACCURACY (K)	STATIC BEAM WIDTH θ_B (degrees)	QUASI POLARIZATION	CHARACTERIZATION AT NADIR (REFERENCE ONLY)
8	54.94	0.40	10	0.75	1.5	2.2	QH	11 km ~250 mb
9	55.50	0.33	10	0.75	1.5	2.2	QH	13 km ~ 180 mb
10	57.290344	0.33	.5	0.75	1.5	2.2	QH	17 km ~ 90 mb
11	57.290344±0.217	0.078	.5	1.20	1.5	2.2	QH	19 km ~ 50 mb
12	57.290344±0.3222 ±0.048	0.036	1.2	1.20	1.5	2.2	QH	25 km ~ 25 mb
13	57.290344±0.3222 ±0.022	0.016	1.6	1.50	1.5	2.2	QH	29 km ~ 10 mb
14	57.290344±0.3222 ±0.010	0.008	.5	2.40	1.5	2.2	QH	32 km ~ 6 mb
15	57.290344±0.3222 ±0.0045	0.003	.5	3.60	1.5	2.2	QH	37 km ~ 3 mb
16	87-91.9	2.0	200	.5	2.0	2.2	QV	Window H_2O 150 mm
17	164-167[1]	3.0	200	0.6	2.0	1.1	QH	H_2O 18 mm
18	183.31±7	2.0	100	0.8	2.0	1.1	QH	H_2O 8 mm
19	183.31±4.5	2.0	100	0.8	2.0	1.1	QH	H_2O 4.5 mm
20	183.31±3	1.0	50	0.8	2.0	1.1	QH	H_2O 2.5 mm
21	183.31±1.8	1.0	50	0.8	2.0	1.1	QH	H_2O 1.2 mm
22	183.31±1	0.5	30	0.9	2.0	1.1	QH	H_2O 0.5 mm

CH-01

NOTE: 1   Maximum allowable bandwidth

3.2.1.2.2

All main beam axes of the ATMS shall be coincidental, i.e., they shall be pointing in the same direction (subject to the pointing accuracy requirements of 3.2.1.6) at the same time for any given beam position.

NOTE: In the following sections, if only one beam is discussed it is inferred to represent all beams.

3.2.1.3   Cross-Track Scan

3.2.1.3.1

The ATMS beams shall scan cross-track to the satellite motion.

3.2.1.3.2

The scan direction shall be from sun to anti-sun.

3.2.1.4   Scan Motion and Pattern

3.2.1.4.1

The total scan period shall be 8/3 seconds.

3.2.1.4.2

The ATMS shall use the "integrate-while-scan"-type scan method.

3.2.1.4.3

During each scan period the instrument shall gather data from a minimum of 104 beam positions, each datum to be called a "sample," obtained from a cell corresponding to that beam position

NOTE: The term " Beam Position" means the position of a "Beam-Center," which is defined as the position of the beam (axis or center) at the mid-point of the integration time. The term cell refers to the segment from the start to the end of the integration time.

3.2.1.4.4

Each cell shall have the same integration time.

3.2.1.4.5

The ATMS beams total scan during the earth-viewing sector shall be a total of 105.45° between the center of scan position 1 and the center of scan position 96.

3.2.1.4.6

There shall be a total of 96 Earth-viewing beam positions.

3.2.1.4.7

The 96 beam positions shall be called cell numbers 1 through 96, from sun to anti-sun direction.

3.2.1.4.8

There shall be 48 Earth-viewing cells on either side of nadir.

3.2.1.4.9

The beam center position of each cell shall be separated from the adjacent cell along the

scan direction by 1.11°.

3.2.1.4.10

There shall be a non-cumulative beam center position to center position tolerance of ±0.05°.

3.2.1.4.11

There shall be four beam position groups that are selectable by command to provide a cold (space look) calibration position.

3.2.1.4.12

The primary cold calibration beam position group shall nominally be at 6.66° below the anti-sun normal toward nadir in the scan plane.

3.2.1.4.13

The three "alternate" cold calibration position groups shall nominally be at 8.33°, 10.00° and 13.33° below the anti-sun normal toward nadir in the scan plane.

3.2.1.4.14

There shall be four samples collected from the internal hot calibration position.

3.2.1.4.15

There shall be provisions to command and park the scanner at an Earth-view, cold-space calibration or hot-calibration scan position.

3.2.1.5   Scan Synchronization

3.2.1.5.1

The ATMS shall use the timing signal it receives from the spacecraft via RS-422 every 8 | CH-02
seconds (± 1 ms) to synchronize its scan start with the Cross Track Infrared Sounder (CrIS). In the event the signal is not available, ATMS shall continue its normal scan sequence until a synchronization signal is detected.

3.2.1.6   Beam-Pointing Accuracy

3.2.1.6.1

For each position, the beam-pointing accuracy shall be better than :
- ± 0.10 degrees for the 1.1 degrees beamwidth channels
- ± 0.15 degrees for the 2.2 degrees beamwidth channels
- ± 0.30 degrees for the 5.2 degrees beamwidth channels

The beam pointing knowledge shall be better than ± 0.05 degrees.

NOTE: At each beam position, in both the scan (cross track) and the spacecraft velocity (down track) directions, the beam pointing accuracy is defined as the difference between

the intended and actual beam electrical boresight directions.

3.2.1.6.2
The beam scan angle of every beam position shall be digitized to 14-bit minimum accuracy.

3.2.1.6.3
The digitized beam scan angle position shall be multiplexed with the corresponding radiometric value.

3.2.1.6.4
The scan position digitizer used shall be designed to give position readout anywhere within the 360° rotation.

3.2.1.7   Beam Alignment

3.2.1.7.1
Not used.

3.2.1.7.2
The alignment of the ATMS beam electrical boresight axes shall be measured with respect to an optical alignment cube.

3.2.1.7.3
Offsets of the optical alignment cube relative to the beam electrical boresight axes shall be known to better than $\pm 0.01^{\circ}$.

3.2.1.7.4
The optical alignment cube shall be visible on the nadir side and on the anti-sun side for verifying alignment on the spacecraft.

3.2.1.7.5
The optical cube(s) shall be permanently attached to the instrument and shall not interfere with the instrument operation.

3.2.1.7.6
The beam electrical axis, with respect to the instrument optical alignment cube and the instrument mounting surfaces, shall not be changed by more than $\pm 0.05^{\circ}$ as a result of any testing.

3.2.2   ANTENNA SYSTEM

3.2.2.1   Beamwidth

3.2.2.1.1
The antenna beamwidth for each ATMS channels shall be as defined in Table 3-1.

NOTE: Beamwidth is defined as the half-power points beamwidth (HPBW). The beamwidth in any plane containing the main beam axis (electrical boresight axis) shall be within plus or minus $\pm 10\%$ of the specified value. Beamwidth variation from channel to channel, having the same beamwidth, shall be smaller than 10% of the specified beamwidth value.

3.2.2.2   Not used

3.2.2.3   Polarization

3.2.2.3.1
Each ATMS channel shall meet the quasi-polarization requirements as specified in Table 3-1.

NOTE: ATMS quasi-horizontal and -vertical polarizations are defined by the following two equations:

$$(1) \text{ Quasi Vertical Polarization (QV)} \quad = T_V \cos^2 \theta + T_H \sin^2 \theta$$
$$(2) \text{ Quasi Horizontal Polarization (QH)} \quad = T_V \sin^2 \theta + T_H \cos^2 \theta$$

Notice that from equation (1) and (2), the QV and QH reduce to T_V (with electric field vector perpendicular to the orbital velocity direction) and T_H (with electric field parallel to the orbital velocity direction), respectively, at nadir when θ is zero degree. Here θ is the scan-angle (from nadir). T_V and T_H are the Brightness Temperatures of the Vertically polarized and Horizontally polarized components, respectively, following the conventional definition. (The Vertical polarization is the component whose the electric field is lying in the plane of incidence, and the Horizontal polarization is the component whose electrical field is perpendicular to the plane of incidence.) In other words, the ATMS receives a linear combination of the pure vertical and horizontal components. The total electric field vector of the received wave (either QV, or QH) is lying in a plane perpendicular to the propagation direction and making a polarization angle ϕ_p (in degrees), with respect to a reference (zero degree) line L, which is the intersection of the tangent (at beam center) plane and the plane of incidence. The total electric field vector rotates (i.e. the polarization angle changes) with the nadir angle θ equal to $0°$. For Quasi Vertical, $\phi_p = \theta$. For Quasi Horizontal Polarization, $\phi_p = 90 - \theta$.

3.2.2.4   Beam Efficiency

3.2.2.4.1

The ATMS antenna beam efficiency shall be 95% or better.

3.2.2.4.2

Beam efficiency shall be met at all frequencies and all beam positions.

NOTE: For the purpose of this specification, beam efficiency is defined as the ratio of the power received within the "main lobe" to that of the total power received by the antenna. The "main lobe" is defined as equal to 2.5 times the HPBW. In determining the beam efficiency, the antenna is assumed to be in a radiometrically isotropic environment, i.e., the brightness temperature is the same from every direction.

3.2.2.5   Center Frequency

3.2.2.5.1

Each ATMS channel shall meet the center frequency requirements defined in Table 3-1.

3.2.2.6   Channel Bandwidth

3.2.2.6.1

Each ATMS shall meet the Channel bandwidths defined in Table 3-1.

NOTE: Channel Bandwidths are defined as the half-power point bandwidth and are the maximum acceptable bandwidth per pass-band.

3.2.2.6.2

All channels, regardless of the number of pass-bands, shall have only one output per channel.

NOTE: The number of pass-bands listed in Table 3-1 is the maximum possible values. However, a lesser number of pass-bands can be used, provided the Temperature Sensitivity requirements are met. For example, Channel 18 lists two possible pass-bands which are centered at $(183.31 + 7) = 190.31$ GHz, and $(183.31 – 7) = 176.31$ GHz. But only one of the two pass-bands need be selected, provided the temperature sensitivity value of 0.8 K (or smaller value) can be achieved.

3.2.2.6.3

Each pass-band, within any one channel, shall have equal average system gain over the pass-band bandwidth within ±1 dB.

NOTE: System gain is the overall gain of the ATMS system from the antenna aperture to the instrument output.

3.2.2.6.4   Pass-band Ripple

The peak-to-peak "ripples" within the pass-band bandwidth shall be less than 1.5 dB for at least 80 percent of the center portion of the pass-band bandwidth.

3.2.2.7   Out-of-Band Rejection

3.2.2.7.1

The channel selection filter shall have a gain that is a minimum of 40 dB below the band-center value for all frequencies outside of 0.65 times the specified half-power bandwidths.

3.2.2.8   Stop-bands

3.2.2.8.1

Receiver channel designs that use upper and lower mixer side-bands signals shall employ stop-bands to remove local oscillator noise.

3.2.2.8.2

Stop-bands may also be used to remove any Radio Frequency Interference (RFI) as required.

3.2.2.9   Gain Stability

3.2.2.9.1

The band center gain of each pass-band shall vary no more than ±2 dB over the operating temperature range and life of the instrument.

3.2.2.10   Center Frequency Stability

3.2.2.10.1

Each ATMS Channel shall meet the center frequency stability values listed in Table 3-1.

NOTE: These values are the maximum deviation from the channel center frequency for both long-term and short-term periods. Long-term means that the stability must be maintained over the operational life of the instrument.

3.2.2.11   Temperature Sensitivity -- NEΔT

3.2.2.11.1

Each ATMS Channel shall meet the Noise Equivalent Temperature (NEΔT) values listed in Table 3-1.

NOTE: Temperature sensitivity (NEΔT) of a radiometer is defined as the minimum detectable change of the brightness temperature incident at the antenna-collecting aperture. For the purpose of this specification, the NEΔT values listed in Table 3-1 shall

be defined as the standard deviation of the radiometer output in Kelvin (K) when the antenna is viewing a 300 K uniform and stable target.

3.2.3   CALIBRATION

3.2.3.1   In-Flight Calibration

3.2.3.1.1

There shall be two types of in-flight calibration measurements during each scan period, a "hot" calibration and a "cold" calibration.

3.2.3.1.2

Each calibration measurement shall comprise a minimum of four sample periods.

3.2.3.1.3

Each sample period shall have an integration time equal to the earth view sample integration time.

3.2.3.1.4

All channels shall utilize a "through-the-antenna" calibration method whereby the calibration targets are viewed by the antenna main reflector.

3.2.3.1.5

The "cold" calibration target shall be the cosmic background microwave radiation (cold space).

3.2.3.1.6

At the cold calibration position, the antenna system shall have a clear unobstructed view of cold space.

The design of ATMS shall ensure that the brightness temperature at the cold space calibration position is known with an error of 1 K or less. Accuracy of the measurement (measurement uncertainty) to 1 sigma.

3.2.3.1.7

The "hot" calibration target shall be an instrument ambient target (nominally 300 K).

3.2.3.1.8

The "hot" calibration target shall be thermally isolated from the ATMS structure.

3.2.3.1.9

A minimum of seven independent platinum wire-type temperature sensors shall be distributed through the target to ensure knowledge of the thermal temperature to ± 0.10 K.

3.2.3.1.10

The brightness temperature of the target, at the relevant microwave frequencies of the ATMS, shall be known to an accuracy of $\pm$0.2 K.

Note: This accuracy shall include the error in the knowledge of the thermal temperature of the target, residual temperature gradients across the target, and the uncertainty in the microwave emissivity.

3.2.3.1.11

The calibration targets shall achieve a calculated effective emissivity of 0.9990 or greater.

3.2.3.2   Calibration Accuracy

3.2.3.2.1

The ATMS shall meet the calibration accuracies listed in Table 3-1.

NOTE: Calibration accuracy is defined as the difference (error) between the brightness temperature inferred from the microwave radiometer (referred to the antenna-collecting aperture) and the actual brightness temperature of a blackbody test target directly in front of the antenna. Calibration accuracy is the average long-term error with a time scale longer than 24 hours.

3.2.3.3   Analyses

3.2.3.3.1

The contractor shall demonstrate through laboratory testing and analyses that the overall calibration accuracy, when the instrument is used in its orbital configuration, meets the requirements of Table 3-1.

NOTE: The overall accuracy includes errors contained in the laboratory tests and other effects including:

(1)   transition from the laboratory simulated cold space target to the in-orbit cold space target,

(2)   emissions from the spacecraft and/or other instruments entering the near fields of the radiometer antennas,

(3)   time dependent degradation of the reference targets,

(4)   the error in the knowledge of the thermal temperature of the target, residual temperature gradients across the target, and the uncertainty in the microwave emissivity, and

(5)   the accuracy of the test equipment.

3.2.3.4   Calibration Algorithm

3.2.3.4.1

Individual in-orbit antenna temperature calibration algorithms for each channel shall be provided for each delivered instrument.

3.2.3.5   Ground Calibration

3.2.3.5.1

The ATMS shall be designed so that calibration is only performed once during initial qualification for each delivered instrument. No calibration shall be required after prolonged storage before launch.

3.2.3.6   Sensor Data Processing

3.2.3.6.1   Telemetry

All telemetry and mission data to be transferred to the spacecraft C&DH via the data bus shall be "packetized" using the Consultative Committee on Space Data Systems (CCSDS) Path Protocol Data Unit format defined in CCSDS 701.0-B-2.

3.2.3.6.2   SDR Content

The sensor contractor shall develop algorithms to produce sensor data records (SDRs). SDRs are full-resolution sensor data that are time-referenced, Earth-located, and calibrated by applying the ancillary information, including radiometric and geometric calibration coefficients and geo-referencing parameters such as platform ephemeris. These data are processed to sensor units (e.g., brightness temperature). Calibration, ephemeris, and any other ancillary data necessary to convert the sensor data back to sensor raw data (counts) are included.

The operational SDR shall, at a minimum, consist of the following S/C and ATMS information:
- Spacecraft ID tag.
- ATMS sensor ID or serial number.
- Flight software version number.
- Orbit number.
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Brightness temperature in all channels
- Signal levels from all channels.
- Geo-location: geodetic latitude and longitude for each sample
- Time tag information - beginning of scan time
- Scan index

The contractor shall include in the development of the SDR additional algorithm processes that will:

- Combine the ATMS 2.2 degree, over-sampled, IFOV's in a manner that combines the cross track and along track directions such that 15 area averaged samples are produced. Each sample shall be equivalent to that which would

be obtained from a 3.3 degree IFOV, scanned at a constant rate, on each side of nadir. The Synthesized Cell #1 center shall be at 47.85 degrees from nadir. The brightness temperature for the synthesized footprint shall be the weighted average of averaged data samples.

- Combine ATMS 5.2 degree, over-sampled, IFOV's in a manner that utilizes the cross track direction so that 15 area averaged samples are obtained. Each sample shall be equivalent to that which would be obtained from an IFOV scanned to produce beam centers separated by 3.3 degrees in cross track dimension and 3.3 degrees in along track dimension. The Synthesized Cell #1- center shall be at 47.85 degrees from nadir. The brightness temperature for the synthesized footprint shall be the weighted average of averaged data samples.

CH-01

Consideration should be given to use of a process similar to that of Backus Gilbert, to enhance resolution, thus providing a synthesized IFOV of 3.3 degrees in both along track and cross track dimension.

3.2.4   SYSTEM DYNAMIC RANGE AND LINEARITY

3.2.4.1

The dynamic range of the radiometer system shall be from 3 to 330 K.

3.2.4.2

Within the dynamic range, the radiometer output shall be essentially linear with respect to the input brightness temperature at the antenna aperture.

3.2.4.3

The residual non-linearity at all points within the dynamic range shall be smaller than 10% of the calibration accuracy values listed in Table 3-1.

NOTE: residual non-linearity is defined as the departure from the expected value of an ideal linear radiometer.

3.2.5   ANALOG TO DIGITAL ELECTRONICS

3.2.5.1   General

3.2.5.1.1

The analog-to-digital (A/D) electronics shall consist of a multiplexer and 15-effective-bit A/D converter.

3.2.5.1.2

The allocations for the 15 bits vs. antenna brightness approximate temperature values are shown in Figure 3-2.

3.2.5.2   Multiplexer

3.2.5.2.1

The multiplexer shall not introduce a voltage offset or other errors sufficient to degrade the overall A/D conversion accuracy beyond 0.1% of full scale.

3.2.5.3   Analog-to-Digital Converter

3.2.5.3.1

The accuracy of the A/D converter at 15° C shall be plus or minus 1 Least Significant Bit (LSB) maximum allowable error.

3.2.5.3.2

The differential non-linearity (the bit-to-bit variation) shall not exceed plus or minus 1 bit.

3.2.5.3.3

Over the instrument mounting foot/baseplate temperature range of -10° C to +40° C the maximum allowable error shall not exceed ±1 LSB.

3.2.5.4   Independence of Measurements of Each Channel

3.2.5.4.1

The output signal presented to the A/D for each channel sample period shall be independent of past signals in that channel.

3.2.5.4.2

The A/D output of each channel sample period shall not be in error by more than 0.01% (of full scale) because of any previous signals in that channel or cross-talk from other channels.

3.2.6   ELECTRONIC CONTROL LOOP STABILITY

3.2.6.1

All closed-loop circuitry shall have a minimum of 12 dB gain margin and a 25 degrees phase margin.
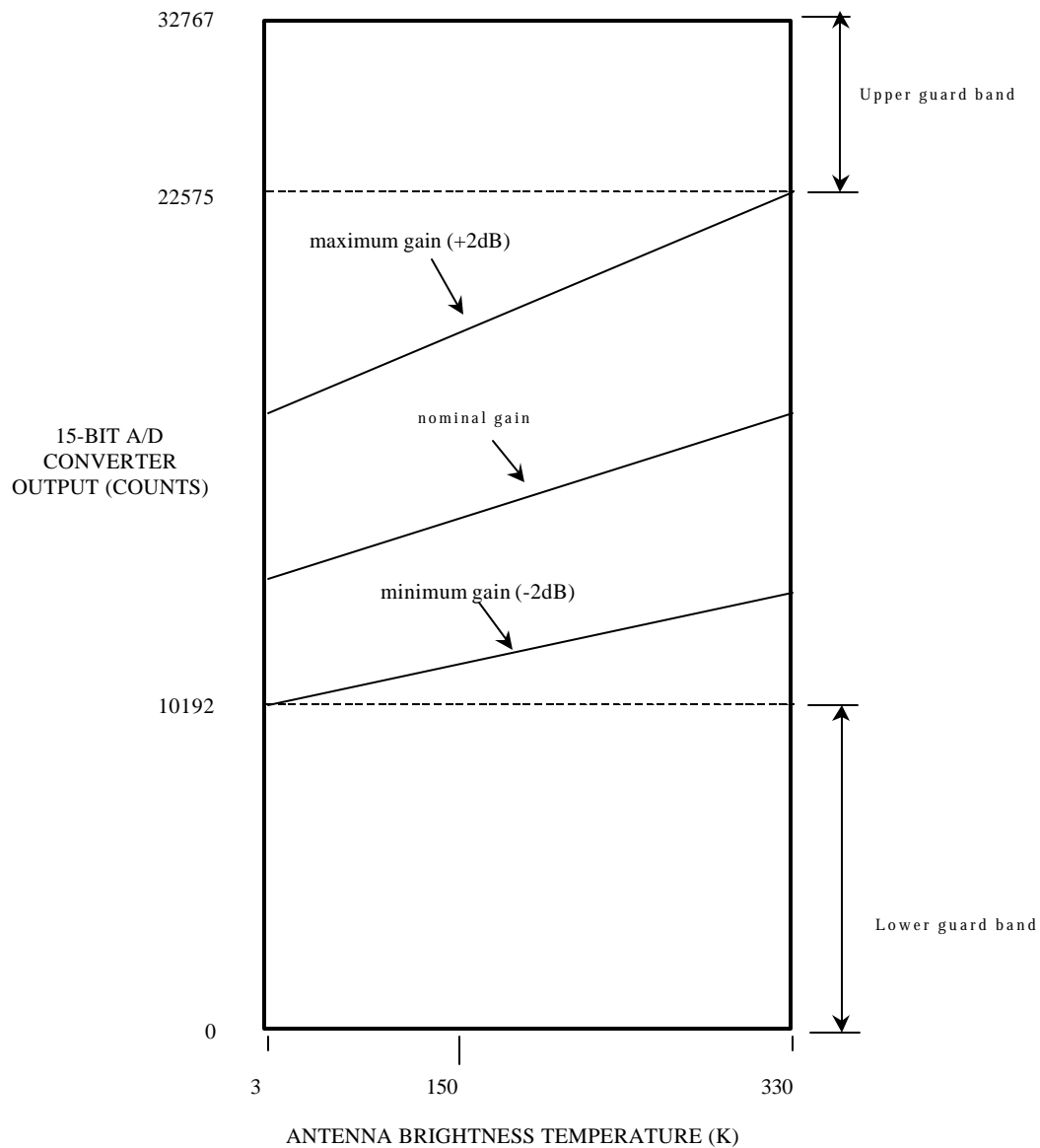
Figure 3-2   A/D Converter

3.3   INTERFACE REQUIREMENTS

The sensor interfaces are depicted in Figure 3-3.
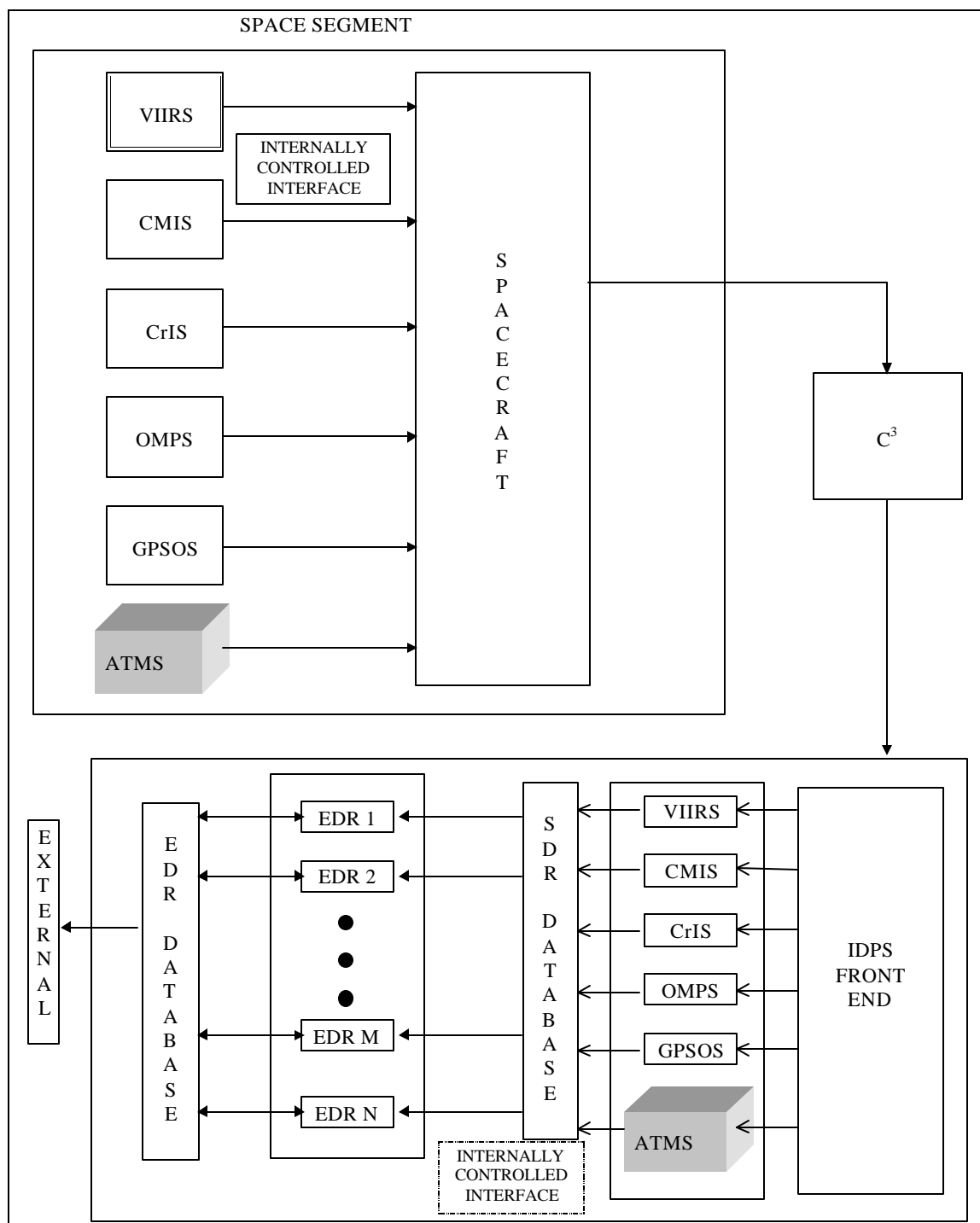
Figure 3-3   Sensor Interfaces on the NPOESS Spacecraft

3.4   PHYSICAL AND INTERFACE CHARACTERISTICS

The mass, average power, volume, and data rate budgets for the ATMS are provided herein. These values are the maximum allowed and include margin. The spacecraft-to-sensor interface requirements are broken down into four primary groups: mechanical,

power, data, and thermal. A notional diagram of the top-level functional interfaces for any sensor is shown in Figure 3-4.
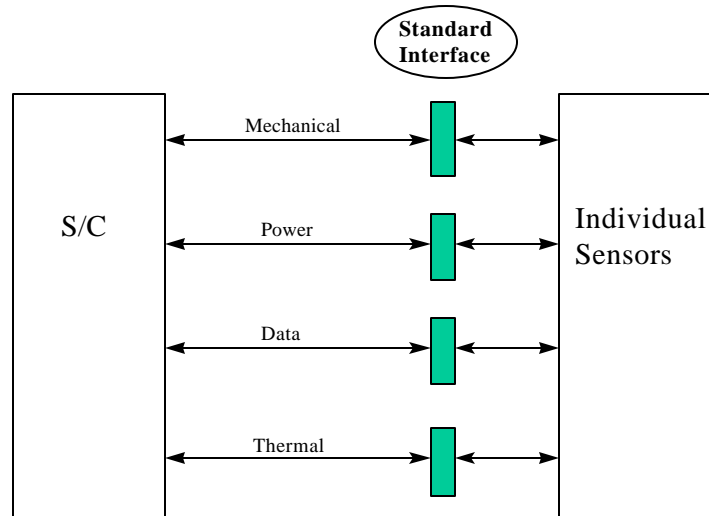
Figure 3-4   Notional Spacecraft-to-Sensor Functional Interfaces

3.4.1   MASS

The mass of the ATMS shall be less than or equal to 73 kilograms. | CH-04

3.4.2   SIZE

The stowed dimensions of ATMS shall be less than or equal to the following limits:

   (a)   Velocity direction: 70 cm

   (b)   Nadir direction: 60 cm

   (c)   Anti-solar direction: 40 cm

3.4.3   POWER

The average steady-state power consumption for ATMS shall be less than or equal to 98 | CH-04
Watts.

3.4.4   DATA RATE AND FORMAT

3.4.4.1   Data Rate

The science data rate of the ATMS, at any moment in the orbit, shall be less than or equal to 50 kbps.

The house-keeping data rate of the ATMS shall be less than 2 kbps.

3.4.4.2   Output Format

Instrument CCSDS output format shall contain spacecraft supplied data (i.e., ephemeris, time tag, etc.). This data shall be transferred via the MIL-STD-1553B data bus.

3.4.5   THERMAL

3.4.5.1   Blanketing

The thermal design of the NPP and NPOESS instruments shall be identical except they may have different external thermal blanket configurations that are not permanently attached.

Continue to Appendix D, ATMS Exceptions to the NPOESS/NPP General Instrument Interface Document (GIID).   CH-03

APPENDIX A.   DELETED   CH-03

APPENDIX B.   DELETED

CH-03

APPENDIX C.   ACRONYMS AND ABREVIATIONS

Acronyms And Abbreviations

Acronym	*Definition*
A/D	Analog/Digital
AFM	Army Field Manual
AMSU	Advanced Microwave Sounding Unit
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
ATMS	Advanced Technology Microwave Sounder
C	Celsius
C&DH	Command and Data Handling
CCSDS	Consultative Committee on Space Data Systems
CDR	Critical Design Review
CDRL	Contract Documentation Requirements List
CF	Contractor's Facility
cm	centimeter
CMIS	Conical Microwave Imager Suite
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
CrIS	Cross Track Infrared Sounder
CSRD	Common Section of the Sensor Requirements Document
CTE	Calibration Test Equipment
DACA	Days After Contract Award
dB	Decibel
DC	Direct Current
ÄCDR	Delta Critical Design Review
DID	Data Items Description
DOC	Department of Commerce
DOD	Department of Defense
EDR	Environmental Data Records
EDU	Engineering Development Unit
EEE	Electrical, Electronic, and Electro-mechanical
EM	Engineering Model
EMI	Electro-Magnetic Interference
EOS	Earth Observation System/Satellite
EWR	Eastern Western Range
EVS	Earned Value System
FED	Federal
FM	Flight Model
FMEA	Failure Modes Effect Analysis
FOV	Field of View

Acronym	Definition	
GB	Giga Byte	
GFE	Government Furnished Equipment	
GHB	Goddard Handbook	
GHz	Gigahertz	
GIID	General Instrument Interface Document	CH-03
GPS	Global Positioning Satellite/System	
GPSOS	Global Positioning Satellite Occultation Sensor	
GSE	Ground Support Equipment	
GSFC	Goddard Space Flight Center	
H_2O	Water	
HDBK	Handbook	
HPBW	Half-Power Beamwidth	
Hz	Hertz	
ICD	Interface Control Document	
IDPS	Interface Data Processing Segment	
IF	Intermediate Frequency	
IORD	Integrated Operational Requirements Document	
IRD	Interface Requirements Document	
ISO	International Standards Organization	
IV&V	Independent Verification and Validation	
K	Kelvin	
kbps	Kilobits per second	
kg	Kilogram	
km	Kilometer	
LO	Local Oscillator	
LSB	Least Significant Bit	
mb	Millibar	
METOP	Meteorological Ops/EUMETSAT Meteorological Observation Satellite	
MAR	Mission Assurance Requirements	
METSAT	Meteorological Satellite	
MHz	Megahertz	
MIL	Military	
MIL-HDBK	Military Handbook	
MIL-STD	Military Standard	
mm	Millimeter	
ms	Millisecond	
NAS	National Aerospace Standard	
NASA	National Aeronautics and Space Administration	

Acronym	*Definition*
NEΔT	Noise Equivalent Temperature
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NPPDIS	NPP Data and Information System
OMPS	Ozone Mapper Profiler Suite
PFM	Proto-Flight Model
PETR	Pre-Environmental Test Review
PLLO	Phase Lock Loop Oscillator
POS	Performance and Operations Specification
PPL	Preferred Parts List
QH	Quasi Horizontal
QV	Quasi Vertical
RDR	Raw Date Records
RF	Radio Frequency
RFI	Radio Frequency Interference
RH	Relative Humidity
S/C	Spacecraft
SDR	Sensor Data Records
SDS	Science Data Segment
SOCC	Satellite Operations Control Center
SOW	Statement of Work
Spec	Specification
SRD	Sensor Requirements Document
STE	Special Test Equipment
SysTE	System Test Equipment
TBD	To be Determined
TBR	To be Resolved
TBS	To be Supplied
TIROS	Television Infrared Operational Satellite
TM	Technical Manual
TRD	Technical Requirements Document
TSPR	Total System Performance Responsibility
UIIS	Unique Instrument Interface Specification
VIIRS	Visible Infrared Imaging Radiometer Suite

Acronym	*Definition*
W	Watts
WBS	Work Breakdown Structure
WR	Western Range

**APPENDIX D.   ATMS EXCEPTIONS TO THE NPOESS/NPP
GENERAL INSTRUMENT INTERFACE DOCUMENT (GIID)**

CH-03

1.0   General

1.1   All the sensor requirements of the NPOESS/NPP General Instrument Interface Document (GIID) (Appendix E, whereto attached) shall be met by the ATMS, except as altered by this Appendix. All the items in this appendix shall be considered exceptions to the GIID.

1.2   Conflicts

1.2-1 In the event there is a conflict between this document, the ATMS Performance and Operations Specification (GSFC 429-00-06-03) and the NPOESS General Instrument Interface Document (GIID) the listing below delineates the order of Precedence
> 1. ATMS Statement of Work (GSFC 429-00-06-02)
> 2. ATMS Performance and Operation Specification (GSFC 429-00-06-03)
> 3. ATMS Mission Assurance Requirements (GSFC 429-00-07-03)
> 4. ATMS Unique Instrument Interface Document (UIID) (GSFC 429-99-06-01)
> 5. NPOESS/NPP General Instrument Interface Document (GIID), 06 August 2001 version

1.2-2 Other conflicts shall be resolved by the contracting officer.

1.3   GLOBAL Changes

CH-03

1.3-1
Replace "sensor suite" with "sensor"

1.3-2
Replace "EDR performance" with "performance"

1.4 Unique Changes
Below are listed GIID paragraph numbers together with changes, additions or deletions as they apply.

1.4.1 **ADD**: 3.2.4.2.3.1 Stowed and Critical Clearances
> In addition to the requirements in section 3.2.4.2.3.1-2, the following shall also apply:
> If 'Y' cable is required for 1553 connector then requirement should include: "Y-cable weight and envelope will not be considered part of the instrument allocation."

1.4.2 **ADD**: 3.2.4.2.3.2.6 Special Mounts
> Add after the requirement 3.2.4.2.3.2.6-1:
> The spacecraft contractor is responsible for defining the mounting interface between cold plate and spacecraft platform.

1.4.3 **CHANGE**: 3.2.4.2.3.2.6 Special Mounts
> For ATMS, section 3.2.4.2.3.2.6-2 reads as follows:
> **From**: The instrument contractor shall provide all kinematic mounts (where used)

including those required for the EDU and Ground Support Equipment (GSE).
To: The spacecraft contractor shall provide all kinematic mounts (where used) between the cold plate and the spacecraft platform.

1.4.4 **DELETE**: 3.2.4.2.3.2.6 Special Mounts
Section 3.2.4.2.3.2.6-3 is not applicable to ATMS.

1.4.5 **CHANGE**: 3.2.4.2.3.3.1 Alignment Responsibilities
For ATMS, section 3.2.4.2.3.3.1-5 reads as follows:
From: The instrument contractor shall allocate for the spacecraft, in the instrument performance budget, no less than 25 arcseconds instrument baseplate to spacecraft frame of reference, not including the uncertainty between the instrument alignment cube and the instrument baseplate (which remains part of the instrument allocation).
To: The NPP UIID allocates pointing requirements to both the instrument and the spacecraft.

1.4.6 **ADD**: 3.2.4.2.3.3.2 Alignment References
In addition to the requirements in section 3.2.4.2.3.3.2-11, the following shall also apply:
Cover not required where all sides of cube are covered by instrument structure and blankets in the flight configuration and are within the walls of the instrument and protected by the blanket during preflight configuration.

1.4.7 **CHANGE**: 3.2.4.3.1.5.2.2.1 Instrument Turn-on Transients
For ATMS, section 3.2.4.3.1.5.2.2.1-1 reads as follows:
From: 50
To: 75

1.4.8 **CHANGE**: 3.2.4.3.1.5.2.2.1 Instrument Turn-on Transients
For ATMS, section 3.2.4.3.1.5.2.2.1-2 reads as follows:
From: 4 times
To: 10 times

1.4.9 **ADD**: 3.2.4.3.1.5.5 Survival Heater Bus
Direct bus connection shall be through a spacecraft fuse for a 20 watt heater maximum.

1.4.10 **CHANGE**: Figure 3.2.4.3.2.1 Spacecraft Grounding Scheme
For ATMS, change figure as follows:
- "Balanced Filter" reads "EMI Filter" at the input to the instrument power supply
- The Power Supply module includes the transformer shown, diagram should show this inclusion
- Spacecraft power is tapped at the primary to support other instrument functions.

CH-03

1.4.11 **CHANGE**: 3.2.4.3.2.5 Chassis Ground
For ATMS, section 3.2.4.3.2.5-6 reads as follows:
From: "…with a resistance of less than 2.5 milli-ohms"
To: "…with a resistance that shall not exceed 5.0 milli-ohms"

1.4.12 **ADD**: 3.2.4.3.3.1.6 Buffer Connectors and Connector Savers
Patch Cables/ Connector Savers
1. Patch cables/connector savers shall be provided and installed as soon as the instrument is assembled. They are used to limit the number of mate/demate cycles on the ATMS connectors.
2. Mates and de-mates on the flight connector shall be limited to six each total before delivery to the spacecraft contractor.
3. Mate/demate logs shall be established and maintained for all flight instrument interface connectors.
4. Patch cables/connector savers shall be constructed using standard wire.

1.4.13 **ADD**: 3.2.4.3.3.1.7 Test Connectors
Polarity Reversal
The ATMS shall not be damaged by polarity reversal.

1.4.14 **DELETE**: 3.2.4.4 Survivability
This section is not applicable to ATMS

CH-03

1.4.15 **ADD**: 3.2.4.6 Protective Coatings and Finishes
Normal Relative Humidity Range
The radiometer antenna reflector shall be designed to withstand exposure to a relative humidity of 95% at 30 degree C for 24 hours. The instrument shall also be designed to withstand operation in an environment whose relative humidity may be as high as 60%.

1.4.16 **CHANGE**: 3.2.4.7.1 General
For ATMS, section 3.2.4.7.1-4 reads as follows:
From: The spacecraft shall not be used as a heat source or sink, except as described below.
To: The spacecraft's ATMS Cold Plate shall be used as the primary conductive heat sink for ATMS.

1.4.17 **CHANGE**: 3.2.4.7.2 Thermal Recovery
For ATMS, section 3.2.4.7.2-1 reads as follows:
From: 60 minutes
To: 120 minutes

1.4.18 **CHANGE**: 3.2.4.7.3.1 Heat Transfer To Spacecraft
For ATMS, section 3.2.4.7.3.1-1 reads as follows:
From: The instruments shall be thermally isolated to the maximum extent possible to minimize heat transfer to the spacecraft and other adjacent instruments.
To: The spacecraft shall be used as the primary conductive heat sink.

For ATMS, section 3.2.4.7.3.1-3 reads as follows:
From: The total heat transfer (conducted and radiated) between the instrument and the spacecraft, as well as between the instrument and adjacent instruments, shall not exceed 10.0 watts into or out of the instrument.
To: The total heat transfer between the instrument and the spacecraft, shall not exceed 133.0 watts (98 watts instrument power, 15 watts environmental heat load, 20 watts NPP spacecraft-held margin, all totaling 133 watts) into or out of the instrument.

1.4.19 **DELETE**: 3.2.4.7.3.1 Heat Transfer To Spacecraft
Section 3.2.4.7.3.1-4 is not applicable to ATMS (see 1.4.18)

Section 3.2.4.7.3.1-6 is not applicable to ATMS (see 1.4.18)

Section 3.2.4.7.3.1-7 is not applicable to ATMS (see 1.4.18)

1.4.20 **CHANGE Reserved.**

1.4.21 **CHANGE**: Table 3.2.4.7.3.2 Worst-Case Hot and Cold Flux
For ATMS, Table 3.2.4.7.3.2 reads as follows:

CH-03

	Hot Case	Cold Case
	W/m^2	W/m^2
Solar Radiation	1400	1308
Earth IR Radiation	262	189
Albedo (ratio)	0.387	0.207

1.4.22 **CHANGE**: 3.2.4.7.4.1 Interface Temperature Range
For ATMS, section 3.2.4.7.4.1-1 reads as follows:
From: mechanical
To: mechanical/thermal

From: +40°C
To: +20°C

For ATMS, section 3.2.4.7.4.1-2 reads as follows:
From: mechanical
To: mechanical/thermal

From: +40°C
To: +20°C

For ATMS, section 3.2.4.7.4.1-3 reads as follows:
From: -30°C
To: -20°C

From: +65°C
To: +60°C

1.4.23 **DELETE**: 3.2.4.7.4.2 Thermal Uncertainty Margins
      Section 3.2.4.7.4.2-1 is not applicable to ATMS.

1.4.24 **ADD**: 3.2.4.7.6 Thermal Control Design
      <u>Thermal Interface Control Drawings</u>
      The ATMS contractor shall provide Thermal Interface Control Drawings as
      delineated below:

1. Be scalable with reference dimensions and show orientations of surfaces relative to spacecraft axes.
2. All external surface coatings and materials shall be labeled. Include a table of thermal properties and variations assumed for surfaces. Effective emittances or conductances through blankets shall be noted.
3. A view of all faces of the instrument should be shown
4. Details of the mounting interface shall be shown, such as:
    (a) Number and sizes of mounting feet or surfaces in contact with spacecraft
    (b) Materials used as isolators and dimensions
    (c) Conductances assumed
5. Indicate significant structural material used.
6. Indicate locations and amounts of power dissipated. A power summary or profile should be included which gives power variations for all modes of operations.
7. Indicate all heater locations and dissipated powers for the heaters.
8. Indicate all analog telemetry thermal sensors locations. Specify a control or reference thermal sensor for which temperature limits, as defined in the ICD, are applicable.
9. The drawing must illustrate how the instrument thermal blankets will interface with the spacecraft blanket and the ATMS harness blanket.

1.4.25 **ADD**: 3.2.4.8.4.1 Commands
1. The ATMS shall respond to all command non-motor commands within 1 second of the receipt of the command.
2. The ATMS shall respond to any command motor command within 3 seconds of the receipt of the command.

1.4.26 **CHANGE**: 3.2.4.8.5.2 Point-to-Point Telemetry
      For ATMS, section 3.2.4.8.5.2-3 reads as follows:
      From: ... up to five locations … of 10 sensing devices.
      To: … up to seven locations … of 14 sensing devices.

1.4.27 **CHANGE**: 3.2.5.1 Reliability

CH-03

For ATMS, section 3.2.5.1-1 reads as follows:
From: Each instrument's total system reliability, as defined in the UIID, at the end of 7 years on-orbit life shall be no less than 0.86, unless otherwise specified in the UIID.
To: The ATMS reliability to produce raw data records shall be no less than .86 for channels 3-15 (combined) and .76 for all other channels (combined) at the end of 7 years on-orbit life.

1.4.28 **ADD**: 3.2.5.1.2 Maintainability
Redundant components, if used, shall be activated only by ground command.

1.4.29 **DELETE**: 3.3.2.2.2 Baseline Requirements
Section 3.3.2.2.2.1-3 is not applicable to ATMS.

1.4.30 **CHANGE**: 3.3.2.2.3.1 External RF Environment
For ATMS, section 3.3.2.2.3.1-4 reads as follows:
From: …RF environment (Table 3.3.2.2.3.1) outside its pass band while in the intended operational mode for the respective phase.
To: …RF environment shown in the On Orbit Operation w/o Degradation columns of Table 3.3.2.2.3.1.

1.4.31 **CHANGE**: 3.3.2.2.5.4 Radiated Susceptibility RS103
For ATMS, section 3.3.2.2.5.4-1 reads as follows:
From: …shown in the on-orbit column of Table 3.3.2.2.3.1…
To: …shown in the On Orbit Operation w/o Degradation columns of Table 3.3.2.2.3.1…

CH-03

1.4.32 **CHANGE**: 3.3.12.3.3 Component Stiffness
For ATMS, section 3.3.12.3.3-1 reads as follows:
From: 50 Hz
To: 100 Hz.

1.4.33 **ADD**: 3.3.12.7.3 Instrument Mechanisms
In addition to the requirements in this section the following shall also apply:

1) Torque Margin
The torque capability of the drive motor(s) and any other components in the scan mechanisms shall be sufficient to perform their proper function when the frictional torque is three times the worst predicted case. This includes worst-case combinations of environment (particularly temperature extremes), tolerances, lubricant contamination and/or evaporation, and other possible degradation at the end of the specified operational period.

2) Motor Stall Vulnerability
The drive motor(s) shall not be damaged if powered with start-up currents under locked rotor conditions in an air or vacuum environment for 30 minutes.

The drive motors shall not be damaged by any available shutdown mode or sequence.

3) Motor Type
   Motors shall not use brushes or contacting position sensors.

4) Shaft "Encoders"
   The shaft position digitizer shall be a non-contacting design. If the digitizer selected is an optical encoder, solid-state redundant light sources shall be utilized. Filament type lamps are not acceptable.

5) Shaft Drive Systems
   Scan drive systems shall be analyzed and tested to ensure that settle characteristics (linearity for continuous scan) meet the appropriate system error budget. Closed-loop scan systems shall have stiffness adequate to insure pointing performance in the presence of at least three times the expected maximum frictional torque and stability margins equivalent to 12 dB gain margin and 25 degree phase margin.

1.4.34 **ADD**: 3.3.12.10.3 Instrument-to-Spacecraft Integration and Test Mounting
In addition to the requirements in section 3.3.12.10.3-3, the following shall also apply:
With exception of the cold plate attachment provided by the spacecraft.   CH-03

1.4.35 **DELETE**: 3.3.11.1.4 Software Coding Conventions
Section 3.3.11.1.4-2 is not applicable to ATMS.

1.4.36 **DELETE**: 3.3.15.1.2.6 Device Cleanliness
Section 3.3.15.1.2.6-5 is not applicable to ATMS.

1.4.37 **CHANGE**: 4.2.3.1 Engineering Development Unit (EDU)
For ATMS, 4.2.3.1-3 reads as follows:
From: 0.1 kg
To: 1.0Kg

1.4.38 **DELETE**: 4.2.4.3 Instrument Performance Math Model
Section 3.2.4.3 is not applicable to ATMS.

1.4.39 **ADD**: 4.2.7 Acceptance and Protoqualification Testing
In addition to the requirements in section 4.2.7-5, the following shall also apply:
Thermal vacuum calibration with a temperature range at the spacecraft-to-instrument mounting surface of -10°C to +20°C and duration of 720 hours shall be considered equivalent to bakeout.

1.4.40 **CHANGE**: 4.2.7.6 Thermal Testing

    The MAR Requirements takes precedence over MIL-STD-1540

1.4.41 **ADD**: 4.2.8 EMC/EMI Testing
    EMI/RFI tests shall be performed with the 'Y' cable, if one is required. The 'Y'
    cable is used to split the ATMS's 1553 and RS-422 signals.

1.4.42 **CHANGE**: 3.2.4.2.3.3.2 Alignment References
    For ATMS, 3.2.4.2.3.3.2-9 reads as follows:
    From: ± 1 Arc Second (arcsec).
    To: ± 10 Arc Second (arcsec).

                                                                CH-03

1.4.43 **CHANGE**: Table 3.3.2.2.3.1 External EMI Environment
    For ATMS, Table 3.3.2.2.3.1 reads as follows:

Frequency (Hz)	Factory/ Transport (V/m)	Launch Pad (V/m)	Ascent (V/m)	On Orbit Survival (V/m)	On Orbit Operation w/o Degradation w/ 1 µsec @ 1000 Hz (V/m)	On Orbit Operation w/o Degradation (other pulse efficiencies and freq.) (V/m)
10 k - 100 M	20	20	20	20	TBD	20(TBR)
100 M - 1 G	20	20	100 (TBR)	20	TBD	20(TBR)
1 G - 5 G	100 (TBR)	100 (TBR)	200 (TBR)	30	TBD	20(TBR)
5G - 10G	100 (TBR)	100 (TBR)	200 (TBR)	110 (TBR)	TBD	20(TBR)
10 G - 40 G	20	20	20	20	TBD	20(TBR)

CH-03

**APPENDIX E.   NATIONAL POLAR-ORBITING OPERATIONAL
ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)/NPOESS
PREPARATORY PROJECT (NPP) GENERAL INSTRUMENT
INTERFACE DOCUMENT (GIID), 06 AUGUST 2001 VERSION**